Remarks

Pending in the application are claims 1-20 of which claims 1, 4, 7, 11, and 16 are independent. The following comments address all stated grounds of rejection and place the presently pending claims, as identified above, in condition for allowance.

I. Summary of the Claimed Invention

The claimed invention discloses a VCSEL comprising a first and second mirror stack. This VCSEL has an active region positioned between the first and second mirror stacks, as well as a contact region in at least one of the active regions. The VCSEL encompasses a module for stabilizing the gains among a plurality of modes in light of spatial power instability. Stabilization occurs by controlling current through the contact region such that a stabilized state may be induced.

II. Claim Rejections under 35 USC §112 first paragraph

Claims 1-20 are rejected under 35. U.S.C §112 first paragraph as containing subject matter which was not described in the specification in such a way to reasonably convey to one skilled in the relevant are that the inventor had possession of the claimed invention at the time the application was filed. In regards to the structural limitations of the various modules, applicant submits that the pending application adequately meets the written description requirement of 35 USC §112. For example, citing page 3 of the specification, the stabilizer module is detailed wherein gains among a plurality of modes are stabilized by increasing the current through the VCSEL contact. Furthermore, citing page 3, lines 16 –18 of the application, applicant submits that the power module is adequately described in conformity with 35 USC §112 first paragraph. As disclosed in the pending application, the power module is capable of measuring spatial and spectral power of the VCSEL. Furthermore, the determination module additional is described wherein the spatial and spectral power of the VCSEL is analyzed to determine if the VCSEL is unstable due to modal gains. Finally, Applicant submits that lines 20-22 of page 3 of the specification sufficiently describe the current module, wherein bias current may be increased, in accordance with 35 USC §112. In light of the above, Applicant

respectfully submits that pending claim 1-20 meet the written description requirement of 35 USC §112 and are therefore in condition for allowance.

III. Claim Rejections under 35 USC §112 second paragraph

Claims 1-20 are rejected as being incomplete for omitting essential structural cooperative relationships of elements. Applicant respectfully traverses this rejection. Addressing the relationship between VCSEL and Stabilizer module, Applicant draws the Examiner's attention to page 3, lines 5-6 of the specification, in which the relationship of VCSEL to stabilizer module is described. Applicant further submits that amended claim 16, which now teaches the communication between stabilizer module and VCSEL, additionally serves to teach the required cooperative relationship between elements as required by 35 USC §112. Applicant further submits that in light of the aforementioned amendment to claim 16, the requisite cooperative relationship between power module, determination module, and current module is adequately detailed. In regards to the cooperative relationship between VCSEL and a first and second module, applicant respectfully submits amended claim 11 now recites the requisite cooperative relationship between the aforementioned elements. In light of such amendment, Applicant urges the Examiner to withdraw his rejection to claims 1-20 under 35 USC §112 second paragraph.

Addressing the Examiner's objection to claims 1-6 under 35 USC §112 second paragraph, applicant submits amended claim 1, which now includes the omitted elements referenced by the Examiner. In light of such an amendment to claim 1, Applicant urges the Examiner to pass claims 1-6 to allowance.

In light of the Examiner's objection to claims 7-10 of the application under 35 USC 35 USC §112 second paragraph for omitting essential steps, applicants submits amended claim 7. Amended independent claim 7 now includes the requisite language which teaches the generation of a plurality of modes within a VCSEL, as well as the generation of a biasing current for use with the VCSEL. Applicant submits that the

addition of this language does not introduce new matter to the pending application but merely serves to clarify pending claim 7. In light of said amendment, Applicant respectfully ask the Examiner to withdraw the rejection to claims 7-10.

Applicant further submits amended claims 10, 14 and 19, all of which have been amended to rectify typographical errors in the originally filed application. Furthermore, claim 13, as amended, now sufficiently recites a device claim wherein bias current is adjusted up to the saturation level of the VCSEL. In light of such an amendment, applicant submits that the aforementioned claims are now in condition for allowance.

III. Rejection of claims 1-20 under 35 USC §102

Claims 1-20 stand rejected under 35 U.S.C. §102 as being anticipated by U.S. Patent No. 6,040,590 to O'Brien et al. The Applicant respectfully traverses this rejection.

O'Brien teaches a means for controlling a plurality of depletion regions in a light emitting device such that the spatial distribution of the carriers in an active layer may be controlled. Under O'Brien, by varying the voltages on the control electrodes of the light emitting device, so long as the voltage remains above the laser threshold, the current density may be sufficiently modulated and the output light intensity controlled. In light of this, modulation of the control voltage delivered to the control electrodes thereby modulates light output. This control of the output intensity may be effectuated in both light emitting diodes (LEDS) as well as within a VCSEL.

Furthermore, the O'Brien reference teaches the stabilization of polarization in a VCSEL by way of utilizing 2 or more sets of opposing control electrodes. One pair of these opposing control electrodes may be fed with a voltage lower than the other pair of opposing control electrodes such that an elliptical output laser beam polarized along the major axis of an ellipse is formed. This allows the stabilization of polarization within a VCSEL by way of controlling the electric field polarization without changing the total number of carriers.

In comparison, the pending invention describes a vertical cavity surface emitting laser (VCSEL) in which mode stabilization can be achieved by increasing the bias current to the VCSEL. The VCSEL in the pending application comprises a first and second mirror stack, with an active region positioned between said mirror stacks. The VCSEL also includes a stabilizer module wherein said module stabilizes gains among a plurality of modes included by spatial power instability by increasing the current through the contact.

In view of the Examiner's rejection to claims 1-20 of the pending application, of which claims 1, 4, 7, 11 and 16 are independent, applicant respectfully submits the following comments over said rejection. Firstly, Applicant submits that the cited art reference of O'Brien fails to each or suggest each element of the pending application. In amended independent claim 1 and pending claim 4 of the present invention, for example a VCSEL is disclosed which includes a stabilizer module for stabilizing gains among a plurality of modes by increasing the current through the contact region. As detailed at page 4, line 31 of the pending specification, this stabilizer module manages the amount of adjusted bias current that is used by the VCSEL. This bias current, as controlled by the stabilizer module, is allowed to vary to accommodate changes in the operating characteristics of the VCSEL. Furthermore, the stabilization module of the pending invention only allows for increases in bias current up to a point that will not saturate the VCSEL. Stabilization of the gains within various modes of a VCSEL thereby results in similar speed across respective modes.

O'Brien, in comparison, teaches a device for controlling the spatial distributions in active layers utilizing control electrodes such that the output light intensity can be controlled. As outlined in claims 1 and 4 of O'Brien, "at least one control electrode biased at a first control potential and once electrode biased at a second control potential to control spatial distribution of said driving current in said active semiconductor medium layer such that said driving current has an elongated cross section profile to make polarization of said photons along the elongation direction." O'Brien fails to disclose the stabilization of modes within a VCSEL, as taught in amended claim 1, by use of a

stabilization module that increases bias current through the contact region, but rather teaches the polarization of photons along an axis. In light of O'Brien's failure to recite the stabilization module element of the pending application, Applicant respectfully requests the passage of claims 1 and 4 to allowance.

Regarding amended independent claim 7, applicant further submits that the O'Brien reference fails to disclose a method for generating a plurality of modes within a VCSEL. The generation of a plurality of modes element of amended claim 7 is clearly not taught by the cited O'Brien reference. Furthermore, O'Brien fails to fails to disclose the adjusting of the bias current of the VCSEL to compensate for the changes in the operating characteristics . Citing independent claims 1 and 14 of O'Brien,

> "a plurality of control electrodes separate from one another and disposed relative to said active semiconductor medium layer, at least one control electrode biased at a first control potential and one control electrode biased at a second control potential to control a spatial distribution of said driving current in said active semiconductor medium layer *such that said driving current has an elongated cross section profile to make a polarization of said photons along the elongation direction.*"

As O'Brien fails to disclose the adjustment of bias current in compensation for changes to the operating characteristics of the VCSEL, but rather discloses the control of bias current to polarize photons, Applicant again urges passage of claim 7 to allowance.

Regarding independent claim 11 of the pending application, Applicant again submits that the cited art reference fails to disclose the first module in which a determination of whether modes in the VCSEL are unstable based on changes in the operating characteristics is completed. Looking to the alleged first module language cited by the Examiner, there exists no language reciting the *detection of instability within the modes of a VCSEL based on changes in operating characteristics.*. In lieu of this, Applicant submits that the first module of claim 11 is not anticipated by the cited prior art. Additionally, Applicant submits that the second module of claim 11 is further not anticipated by the cited art as the stabilization of modes by way of adjustment of bias current in response to changes in the operating characteristics is not taught. Rather, as cited by the Examiner at page 5 of the Office Action, the depletion region of each control

electrode may be increased, and the spatial profile of the driving current decreased in response to changes in bias current. Absent in such a citation, however, is the *stabilization of modes to compensate for changes in the operating characteristics*, as taught in claim 11. Changes in the operating characteristics, as taught in the pending specification, include modal instability induced after an initial burn in following a few months of regular operation. In light of the above, applicant submits that the first and second modules of the pending application are not anticipated by the O'Brien citation.

Regarding the power module, determination module, and current module of the pending application, Applicant further submits that said elements are not disclosed by the cited art to O'Brien. In pending independent claim 16, a power module for measuring spatial and spectral power of the VCSEL is disclosed. Such an element for measuring spatial and spectral power is clearly not recited in the O'Brien reference. Additionally, the determination and current modules of claim 16 are not recited by O'Brien. As taught in claim 16, the current module is in communication with the determination module such that bias current is increase to a level where the VCSEL is stable, following a determination by the determination module that the VCSEL is operating in an unstable condition. A determination and current module connection such as this is clearly not evidenced by the cited text of O'Brien,

Furthermore, Applicant submits that the Examiner's assertion that O'Brien *implies* the aforementioned first module, second module, power module, determination module and current module is unsubstantiated basis by which a 35 U.S.C. §102 rejection may be lodged. Applicant therefore respectfully requests passage of claim 1-20 to allowance.

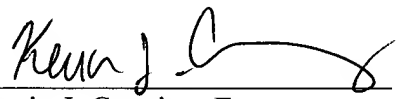
Conclusion

It is believed that the claims in their current form distinguish over the cited references. Additionally, the introduction of claim 21 to the application introduces no new matter. Should the examiner feel that a telephone conference with Applicants'

attorney would expedite prosecution of this application, the Examiner is urged to contact the Applicants' attorney at (617) 227-7400.

Respectfully submitted,

LAHIVE & COCKFIELD, LLP



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Version with Markings to Show Changes Made

In the Claims:

1. (Amended) A vertical cavity surface emitting laser (VCSEL) comprising:

a vertical cavity region,

an active region;

a contact region in at least one side of the active region providing current to be distributed through the active region;

a stabilizer module for stabilizing the gains among a plurality of modes induced by spatial power instability by increasing the current through the contact region;

and a pumping means for exciting the CVSEL laser to emit light.

7. (Amended) A method for stabilizing modes in VCSEL, said method comprising:

generating a plurality of modes within said VCSEL;

determining whether the modes in the VCSEL are unstable based on changes in operating characteristics of the VCSEL;

generating an adjustable bias current for stabilizing the modes in the VCSEL; and

adjusting bias current of the VCSEL to stabilize the modes to compensate for the changes in the operating characteristics.

10. (Amended) The method as recited in claim 7 [11] wherein the VCSEL is used in high-speed communication links over a multimode fiber

11. (amended) A system for stabilizing modes in a VCSEL, said system comprises:

a first module in communication with a VCSEL, wherein said first module is used for determining whether the modes in the VCSEL are unstable based on changes of the operating characteristics; and

a second module in communication with a VCSEL, wherein said second module is used for adjusting bias current of the VCSEL to stabilize the modes to compensate for the changes in the operating characteristics

13 (Amended) The system as recited in claim 11 wherein the [step of adjusting] bias current is adjusted [further comprises adjusting bias current] up to the saturation level of the VCSEL.

14. (Amended) The system L as recited in claim 11 wherein the VCSEL is used in applications of 1.2 Gb/s and 2.5 Gb/s frequencies.

16. (Amended) A stabilizer module in communication with [for stabilizing] a VCSEL, the stabilizer module comprising:

a power module for measuring spatial and spectral power of the VCSEL;

a determination module for determining whether the spatial and spectral power of the VCSEL is unstable because of modal gains; and

a current module for increasing bias current to a level where the VCSEL is stable if it is determined that the VCSEL is not stable.

19. (Amended) The stabilizer module as recited in claim 16 wherein the VCSEL is used in applications of 1.2 Gb/s and 2.5 Gb/s frequencies.

21. (New) A vertical cavity means in accordance with claim 1, wherein said vertical cavity is defined by a plurality of mirror stacks.